CENTRAL DETECTOR SUB-SYSTEMS FOR INTERACTION POINT 6

1.5 TESLA REFERENCE DETECTOR

OVERVIEW AND ASSUMPTIONS

Overview

In order to simplify the development and adaptation of central detector models for the Electron Ion Collider project, a collection of drop-in dynamic components has been developed. These components, which are based on Trimble Sketchup, are dramatically simplified representations of the engineering models and have user configurable settings that allow their dimensions, position and other parameters to be easily altered. For several of the expected configurations, an initial model has been created that contains all of the components in their default configuration. This document provides a list of the components in the 1.5-Tesla model for Interaction Point 6, along with all of their initial parameters. Using this document, in conjunction with the *Detector Menagerie* of dynamic components, any user should be able to reconstruct this model and then make alterations to suit their preferred configurations.

A separate document will be available that provides a description of each of the components, their configuration options and how they can be best used. As these dynamic components continue to be developed, automatic volume calculations and other features will be added to assist in using them for weight and material calculations.

Keep in mind that these objects are for conceptual design only. While they are very effective for facilitating the exchange of ideas, they do not constitute an engineering design.

Assumptions

The following are design assumptions related to the 1.5 T BABAR Magnet in IP-6. These assumptions governed the construction of the initial model and the component parameters that are included in this document.

- Because of interference with the RCS beamline, the maximum outer radius of the detector cannot exceed 3.2 meters.
- The maximum length of the detector cannot exceed 9.5 meters (4.5 meters in the lepton direction, and 5 meters in the hadron direction.)
- The crossing angle at IP-6 is fixed at 25 mrads, with 8 mrads in the electron beam and 17 mrads in the hadron beam.
- The axis of the solenoid must be aligned with the electron beam, thus the central detector is rotated by 8 mrads.
- As much as possible will be reused from the IP-6 infrastructure; i.e. rail systems, cradle, platform components, etc.
- To be able to reuse the STAR cradle, we offset the 1.5 Tesla magnet by 20 cm in the forward (hadron direction) side. *(This alteration also makes it possible to move this magnet through the doorway of IP-8 once the end caps have been removed.)*
- The hadron calorimeter endcap on the lepton side will remain in the collider hall during maintenance.
- The hadron calorimeter endcap and the electromagnetic calorimeter on the hadron side will remain in the hall during maintenance.

- The cryo-can will be in a fixed position in the collider hall and will be connected to the solenoid cryostat using a flexible cryo-line.
- Based on preliminary engineering designs by Roland Wimmer, we assume that the support structure for the barrel EMCal will be 7.62 cm thick and will be installed between the solenoid cryostat and the barrel EMCal.
- Based on another adaptation of Wimmer's engineering design, we assume a universal support structure for the DIRC that will be 16 cm thick. This may be more substantial than needed in some configurations, but will allow the DIRC support to be used to also support other heavier components within the barrel.

1.5 TESLA

IP-6 FIXED CARRIAGE

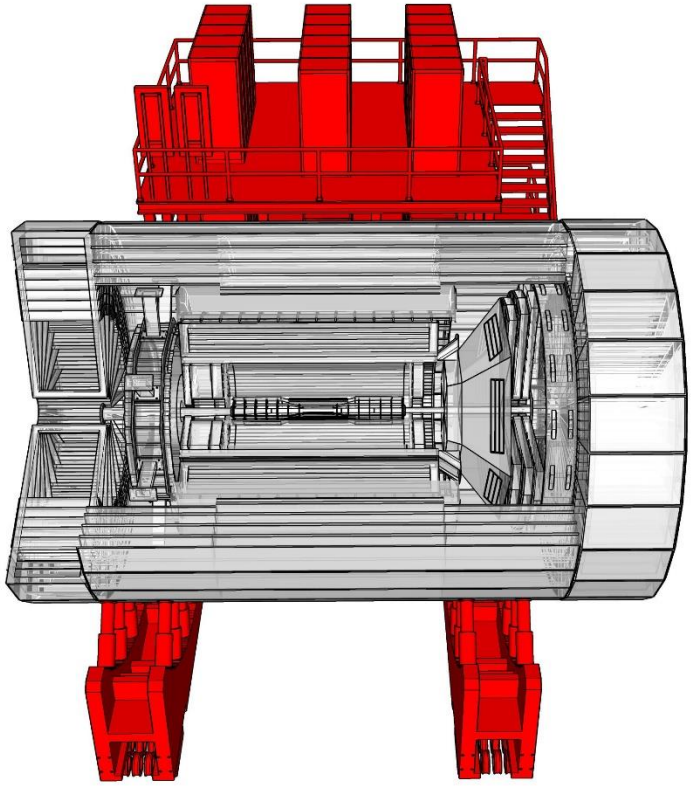

Figure 1: IP-6 Fixed Carriage

Dimensions/Location

N/A

Weight Estimates

Element	*Basis*	*Weight*
Carriage (5.92 m³ Steel)	7850 kg/m³	46,452 kg
STAR Cradles (6.88 m³ Steel)	7850 kg/m³	54,046 kg
Danfysik Power Supplies	2 @ 850kg	1,700 kg
Computing Racks	39 @ 227kg	8,845 kg
Transformers	4 @ 231kg	925 kg
	Total:	111,968 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

BARREL HADRON CALORIMETER

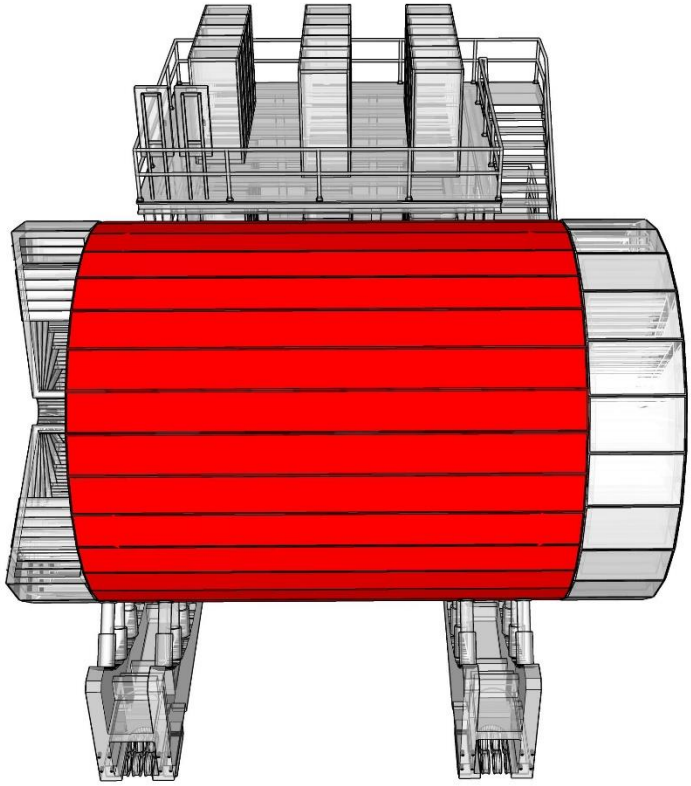

Figure 2: Barrel Hadron Calorimeter

Dimensions/Location

Overall Length	640 cm
Lepton Direction Section Length	170 cm
Center Section Length	300 cm
Hadron Direction Section Length	170 cm
Lepton Direction Bore	194 cm
Center Bore	180 cm
Hadron Direction Bore	194 cm
Radius	267 cm
Offset	20 cm in Lepton Direction
Total Volume	72.60 m^3

Weight Estimates

Element	*Basis*	*Weight*
57.4 m^3 of Iron	7,847 kg/m^3	450,046 kg
15.2 m^3 of Plastic	970 kg/m^3	14,788 kg
Cabling		
	Total:	464,834 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

LEPTON DIRECTION HADRON CALORIMETER ENDCAP

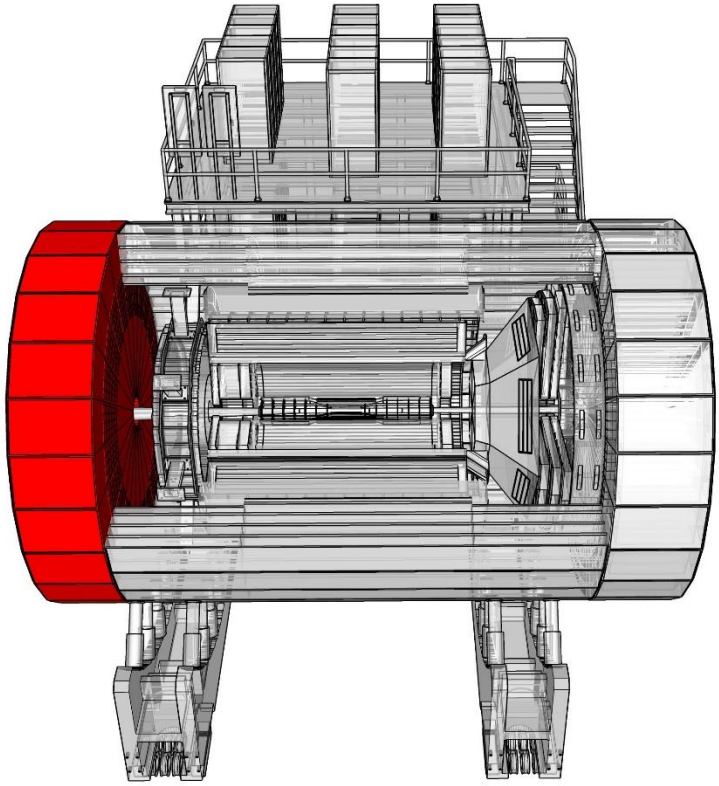

Figure 3: Lepton Direction Endcap

Dimensions/Location

Overall Length	105 cm
Bore	22 cm
Radius	267 cm
Offset	300 cm in Lepton Direction
Total Volume	23.36 m^3

Weight Estimates

Element	*Basis*	*Weight*
18.5 m^3 of Iron	7,847 kg/m^3	144,788 kg
4.9 m^3 of Plastic	970 kg/m^3	4,758 kg
Cabling		
	Total:	149,546 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

HADRON DIRECTION HADRON CALORIMETER ENDCAP

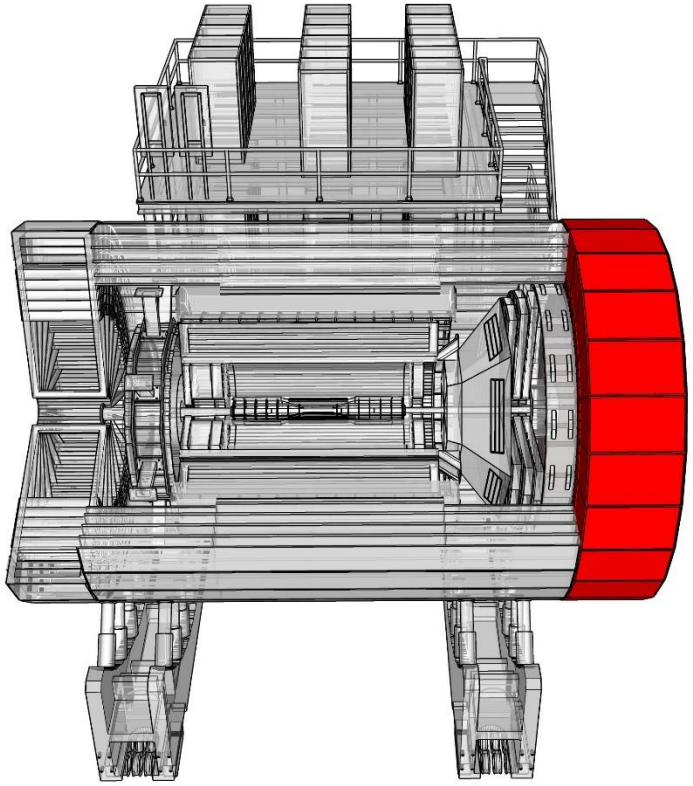

Figure 4: Hadron Direction Endcap

Dimensions/Location

Overall Length	120 cm
Bore	30 cm
Radius	267 cm
Offset	340 cm in Hadron Direction
Total Volume	26.54 m^3

Weight Estimates

Element	*Basis*	*Weight*
21. m^3 of Iron	7,847 kg/m^3	164,500 kg
5.6 m^3 of Plastic	970 kg/m^3	5,405 kg
Cabling		
	Total:	169,906 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA SOLENOID CRYOSTAT

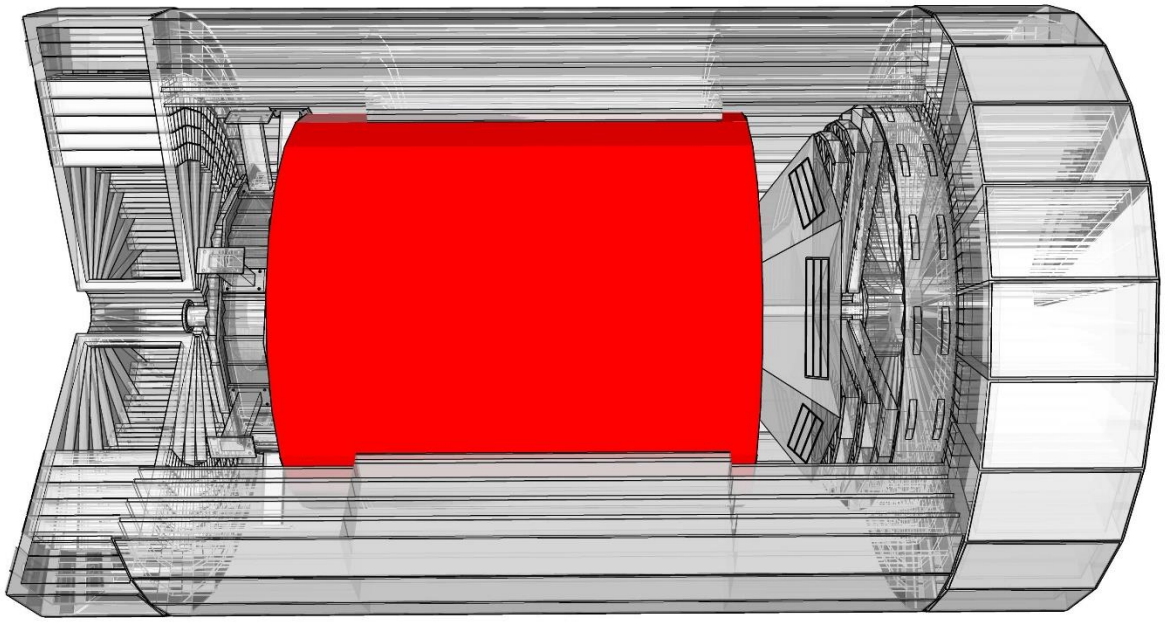

Figure 5: Solenoid Cryostat

Dimensions/Location

Overall Length	384 cm
Bore	142 cm
Radius	177 cm
Offset	0 cm
Total Volume	13.47 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLEO II)	3,412 kg/m³	45,956 kg
Cabling		
	Total:	45,956 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

BARREL SUPPORT

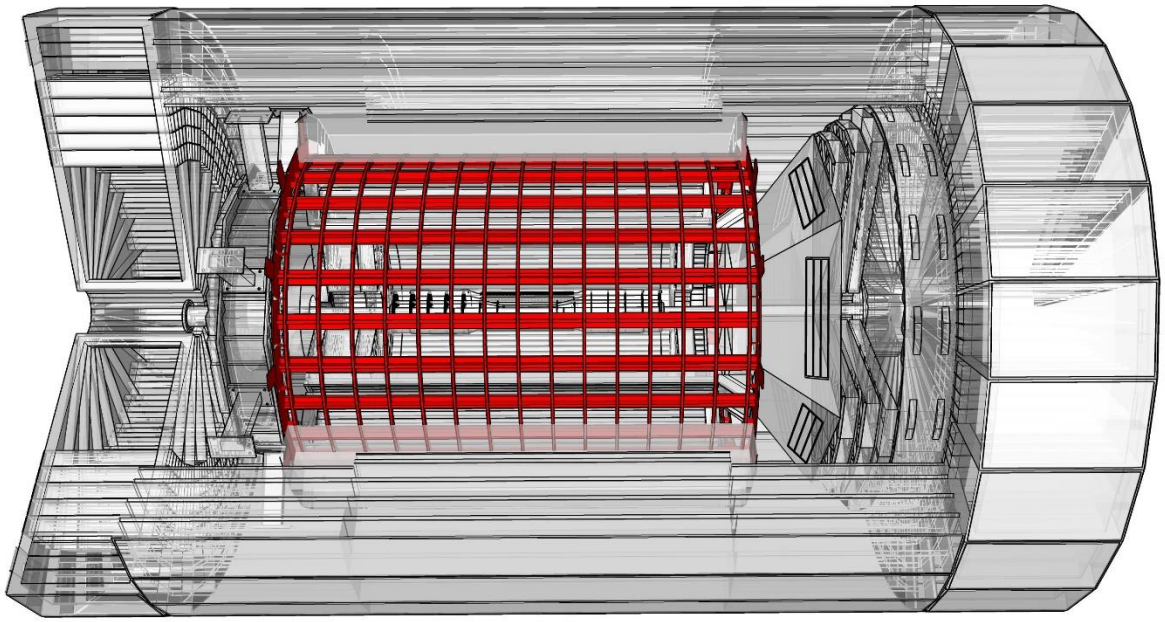

Figure 6: Barrel Support

Dimensions/Location

Structure Length	385 cm
Radius	142 cm
Support Radius	194 cm
Offset	0 cm

Weight Estimates

Element	*Basis*	*Weight*
Data Not Collected		
	Total:	lbs
		tons

1.5 TESLA BARREL ELECTROMAGNETIC CALORIMETER

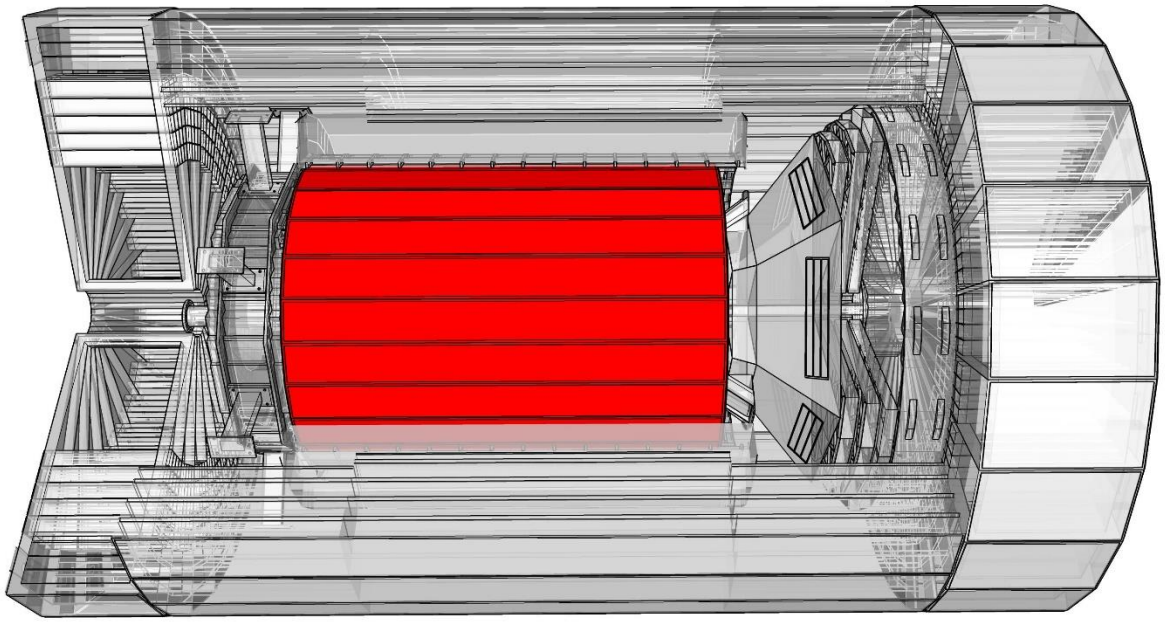

Figure 7: Barrel Electromagnetic Calorimeter

Dimensions/Location

Overall Length	360 cm
Bore	84 cm
Radius	134 cm
Offset	11 cm in Lepton Direction
Total Volume	12.33 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CMS)	3,508 kg/m³	43,246 kg
Cabling		
	Total:	43,246 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA DIRC (DETECTION OF INTERNALLY REFLECTED CHERENKOV LIGHT) DETECTOR

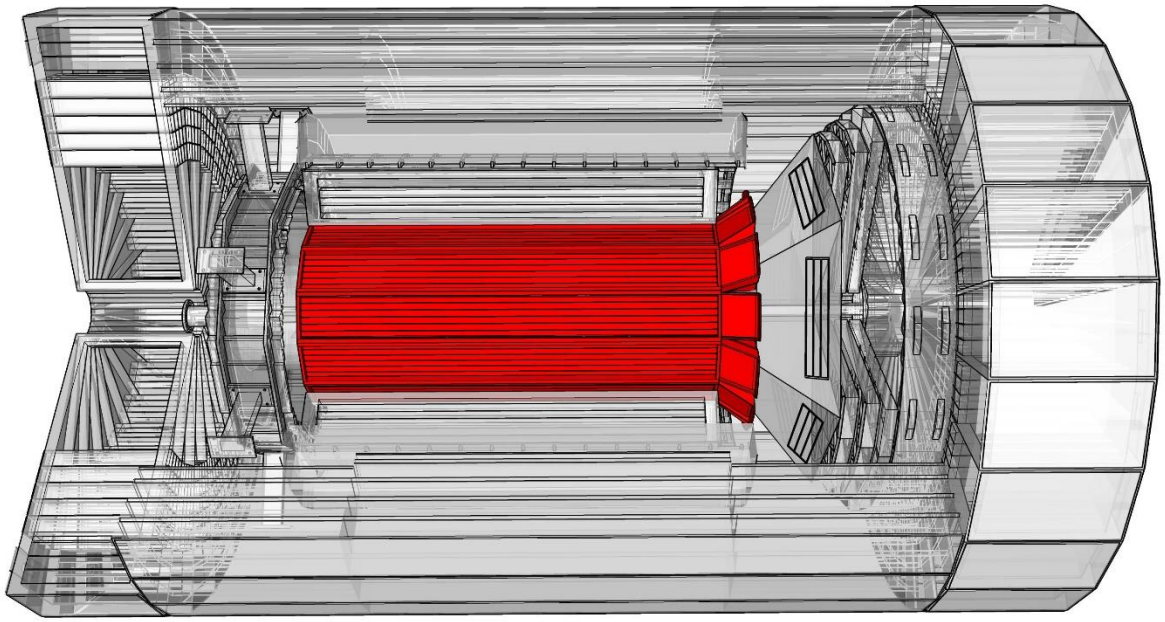

Figure 8: DIRC Detector

Dimensions/Location

DIRC Bar Length	360 cm
DIRC Segment Count	12
Bore	N/A
Radius	81 cm
Offset	169 cm in Hadron Direction
Total Volume	0.78 m^3

Weight Estimates

Element	*Basis*	*Weight*
0.15 m^3 of Steel	7,850 kg/m^3	1,193 kg
0.63 m^3 of Quartz	2,320 kg/m^3	1,452 kg
Cabling		
	Total:	2,645 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA LEPTON DIRECTION ELECTROMAGNETIC CALORIMETER

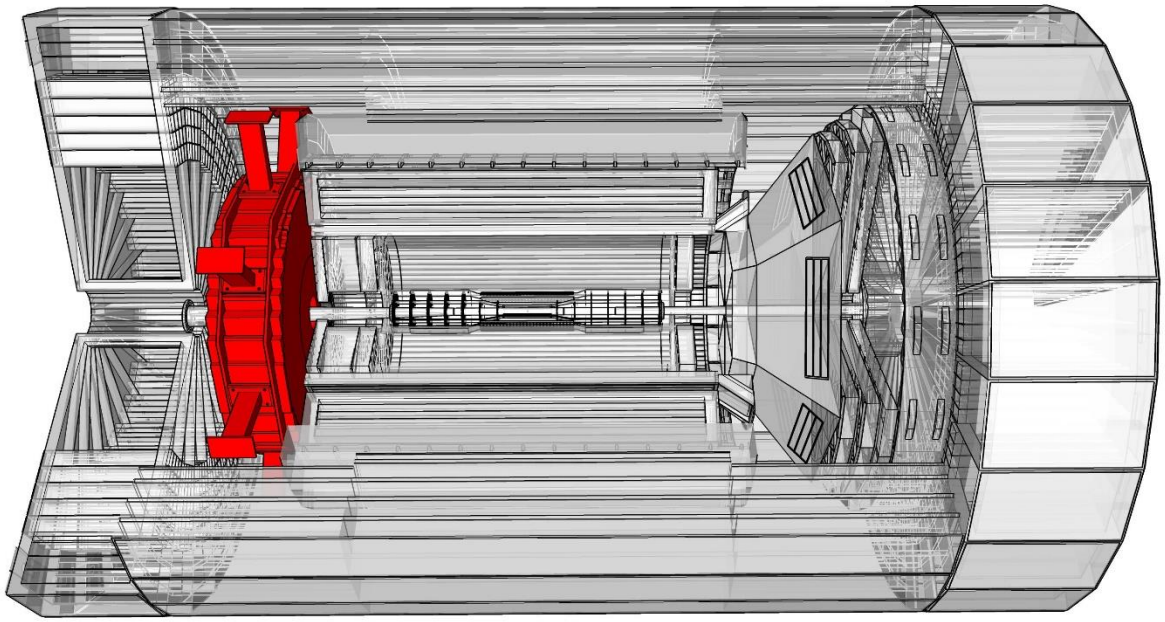

Figure 9: Lepton Direction Electromagnetic Calorimeter

Dimensions/Location

Overall Length	60 cm
Bore	15 cm
Radius	110 cm
Support Radius	194 cm
Offset	195 cm in Lepton Direction
Total Volume	2.64 m³

Weight Estimates

Element	*Basis*	*Weight*
2.2 m³ of Lead Glass	6,220 kg/m³	13,910 kg
0.4 m³ of Steel	7,850 kg/m³	3,199 kg
Cabling		
	Total:	17,110 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA LEPTON DIRECTION TIME OF FLIGHT DETECTOR

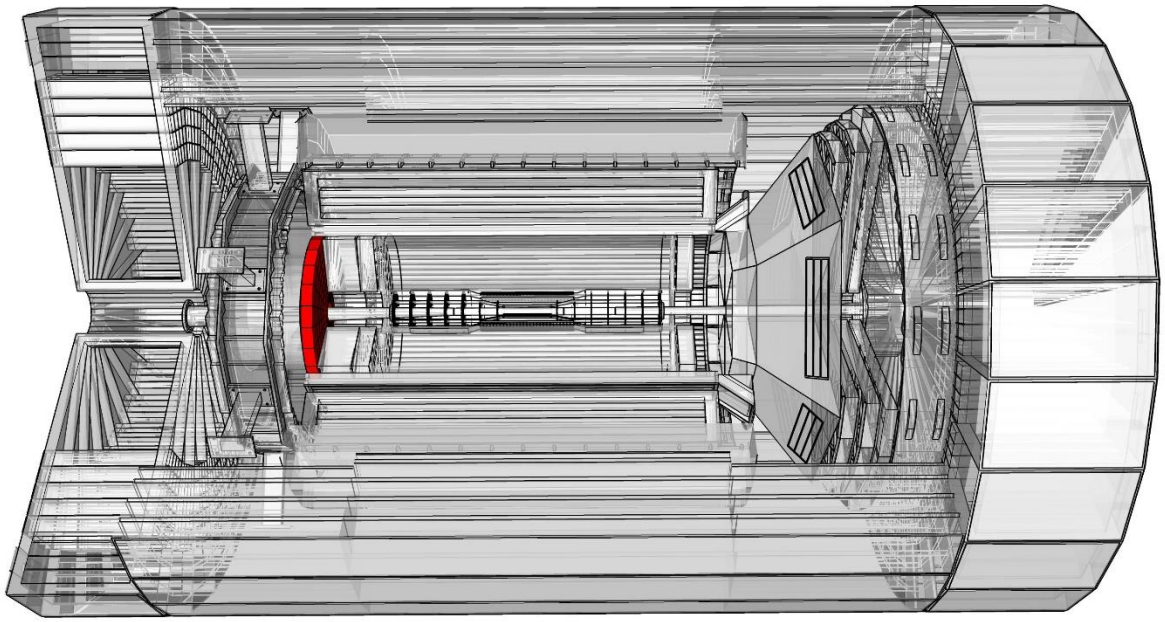

Figure 10: Lepton Direction Time of Flight Detector

Dimensions/Location

Overall Length	10 cm
Bore	10 cm
Radius	71 cm
Offset	180 cm in Lepton Direction
Total Volume	0.16 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (PANDA)	605 kg/m³	94 kg
Cabling		
	Total:	94 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA CHERENKOV COUNTER

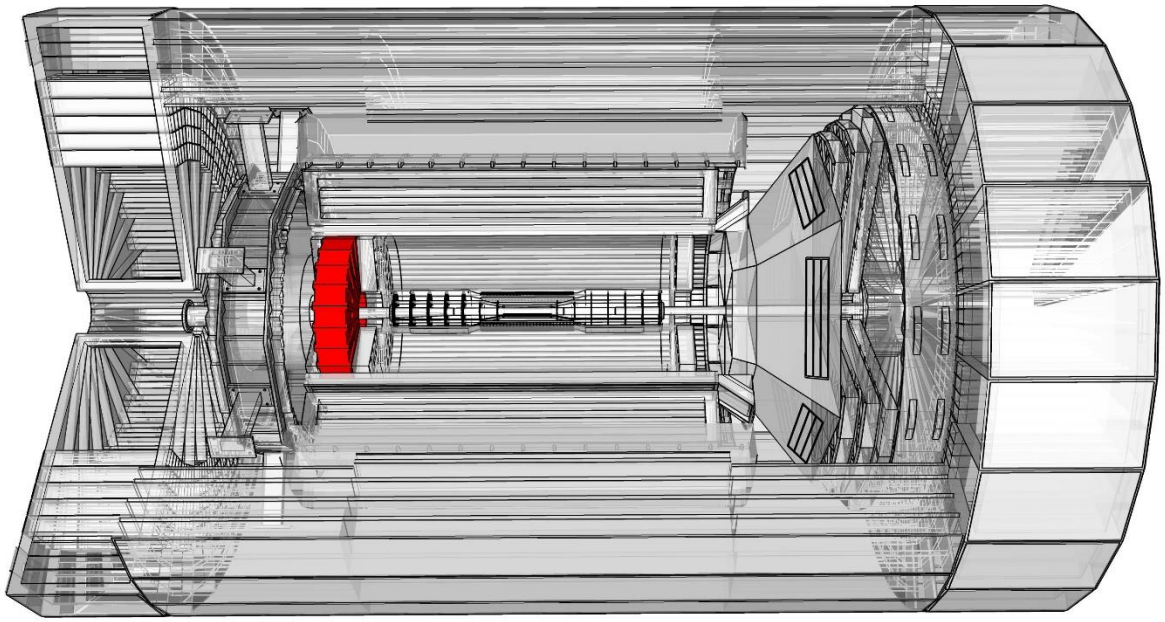

Figure 11: Cherenkov Counter

Dimensions/Location

Overall Length	30 cm
Bore	20 cm
Radius	71 cm
Offset	150 cm in Lepton Direction
Total Volume	0.44 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLAS LTCC)	186 kg/m³	81 kg
Cabling		
	Total:	81 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA LEPTON DIRECTION MICRO-PATTERN GAS DETECTOR

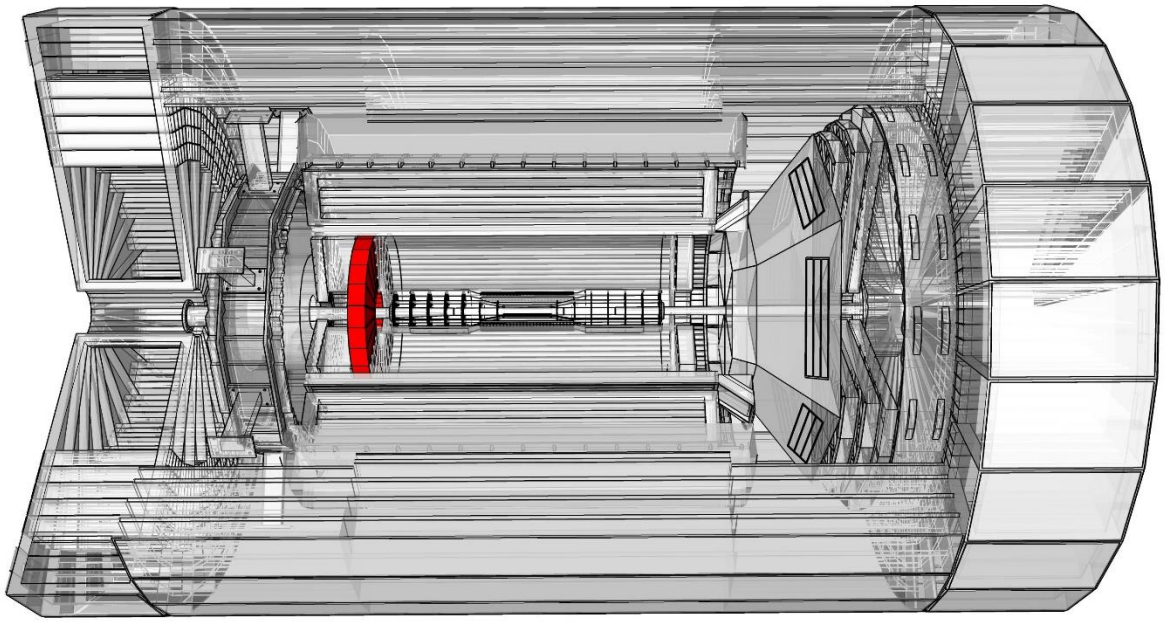

Figure 12: Lepton Direction Micro-Pattern Gas Detector

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	71 cm
Offset	135 cm in Lepton Direction
Total Volume	0.22 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	200 kg/m³	44 kg
Cabling		
	Total:	44 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA OUTER TRACKING

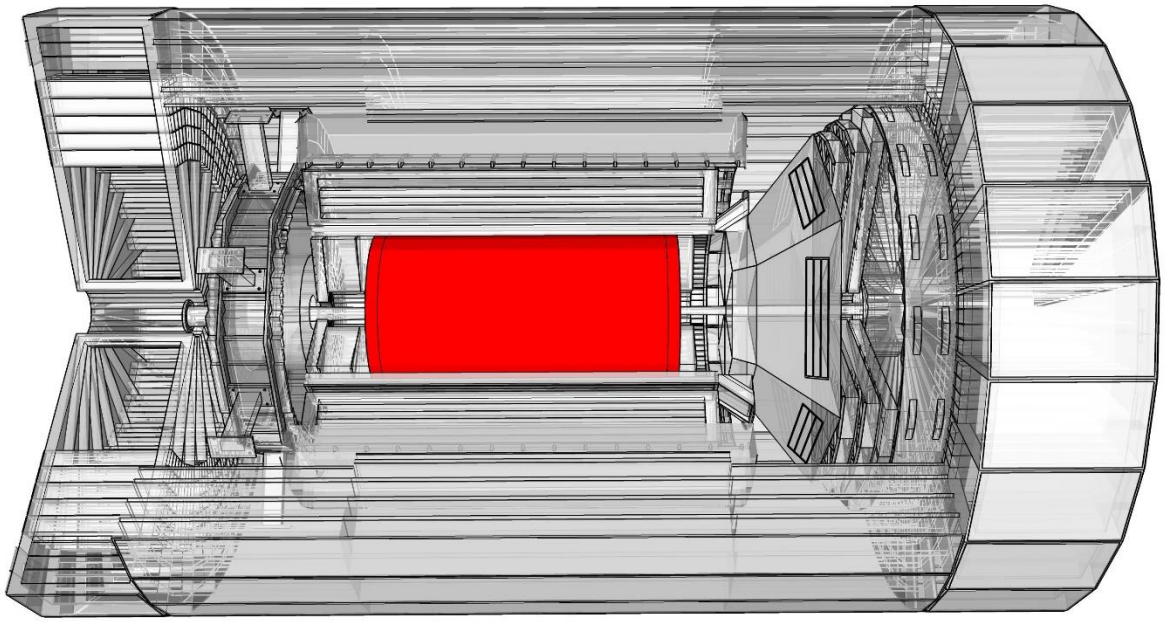

Figure 13: Outer Tracking

Dimensions/Location

Overall Length	270 cm
Bore	20 cm
Radius	71 cm
Offset	0 cm
Total Volume	3.94 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (sPHENIX TPC)	99 kg/m³	390 kg
Cabling		
	Total:	390 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

HADRON DIRECTION MICRO-PATTERN GAS DETECTOR

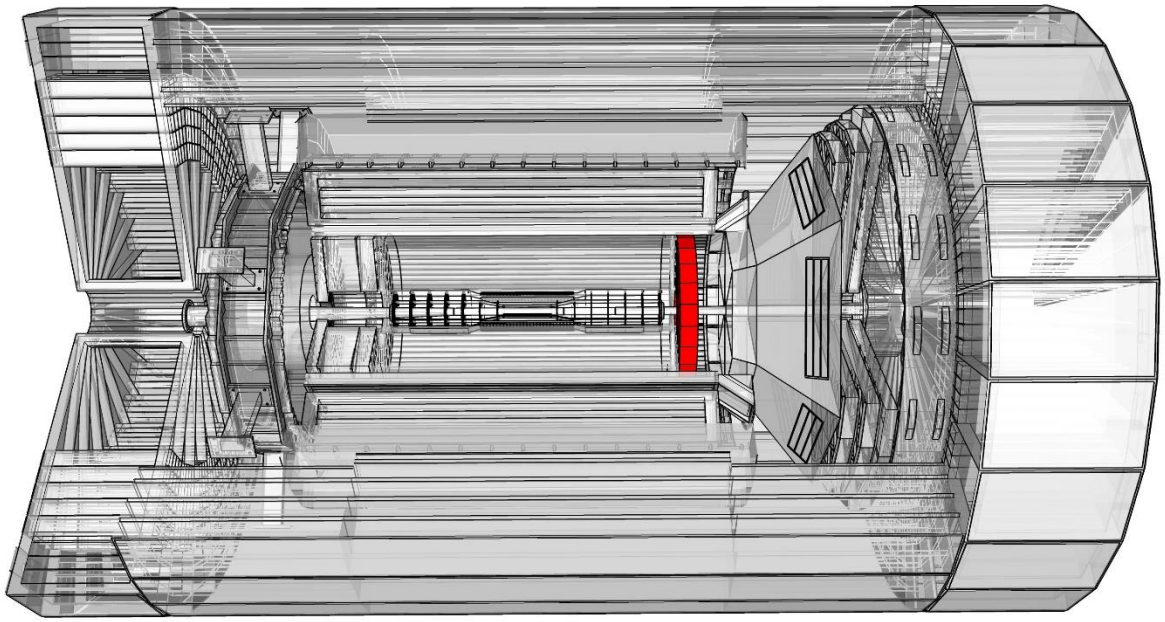

Figure 14: Hadron Direction Micro-Pattern Gas Detector

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	71 cm
Offset	135 cm in Hadron Direction
Total Volume	0.22 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	200 kg/m³	44 kg
Cabling		
	Total:	44 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA RICH (RING IMAGING CHERENKOV) DETECTOR

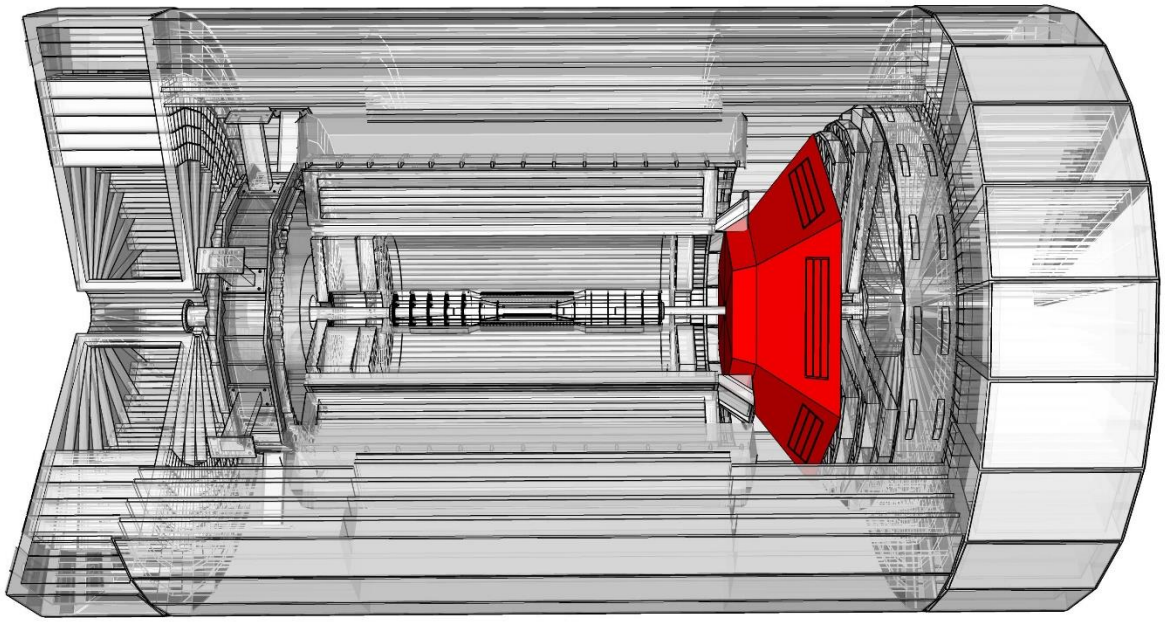

Figure 15: RICH Detector

Dimensions/Location

Overall Length	80 cm
Aerogel Length	20 cm
Aerogel Radius	75 cm
Detector Length	60 cm
Bore	10 cm
HD Radius	160 cm
LD Radius	85 cm
Offset	260 cm in Hadron Direction
Segment Count	6
Total Volume	3.32 m^3

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLAS LTCC)	185.81 kg/m^3	617 kg
Cabling		
	Total:	617 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

HADRON DIRECTION TRANSITION RADIATION DETECTOR 2

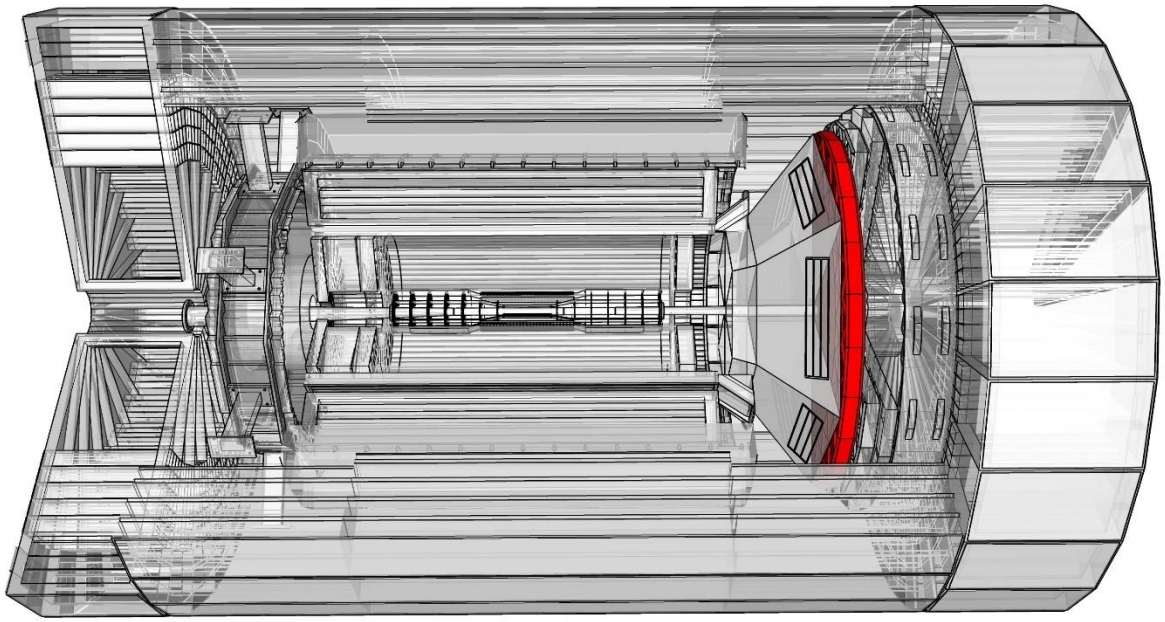

Figure 16: Hadron Direction Transition Radiation Detector 2

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	160 cm
Offset	260 cm in Hadron Direction
Total Volume	1.19 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	239 kg/m³	283 kg
Cabling		
	Total:	283 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

HADRON DIRECTION TRANSITION RADIATION DETECTOR 1

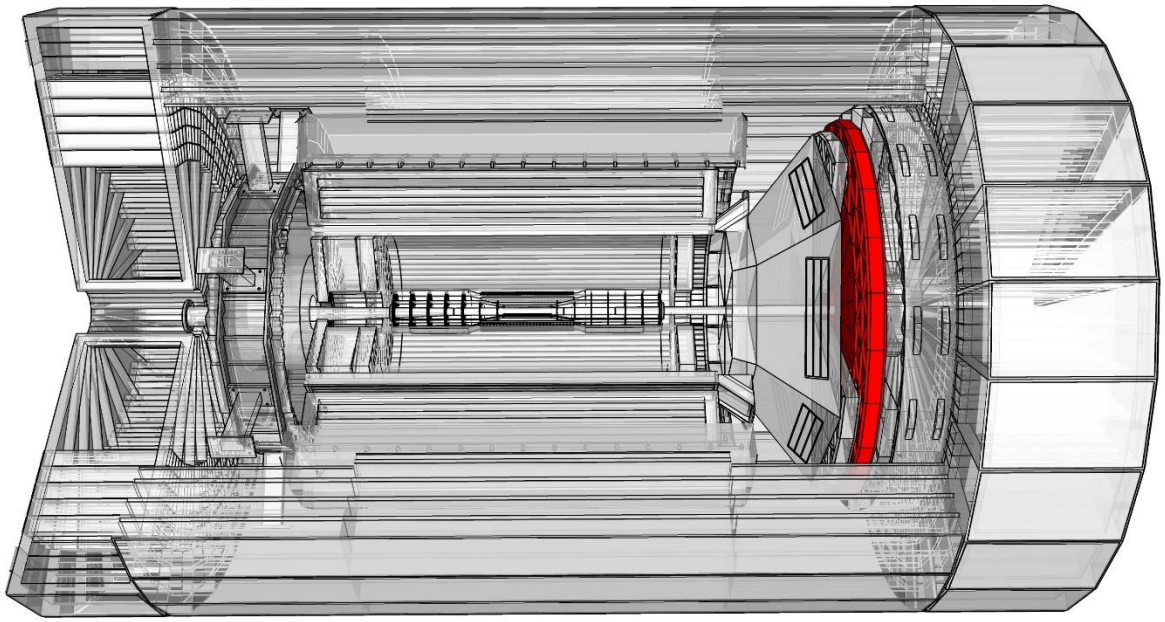

Figure 17: Hadron Direction Transition Radiation Detector 1

Dimensions/Location

Overall Length	15 cm
Bore	20 cm
Radius	170 cm
Offset	275 cm in Hadron Direction
Total Volume	1.34 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (SBS GEM)	239 kg/m³	321 kg
Cabling		
	Total:	321 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

HADRON DIRECTION TIME OF FLIGHT DETECTOR

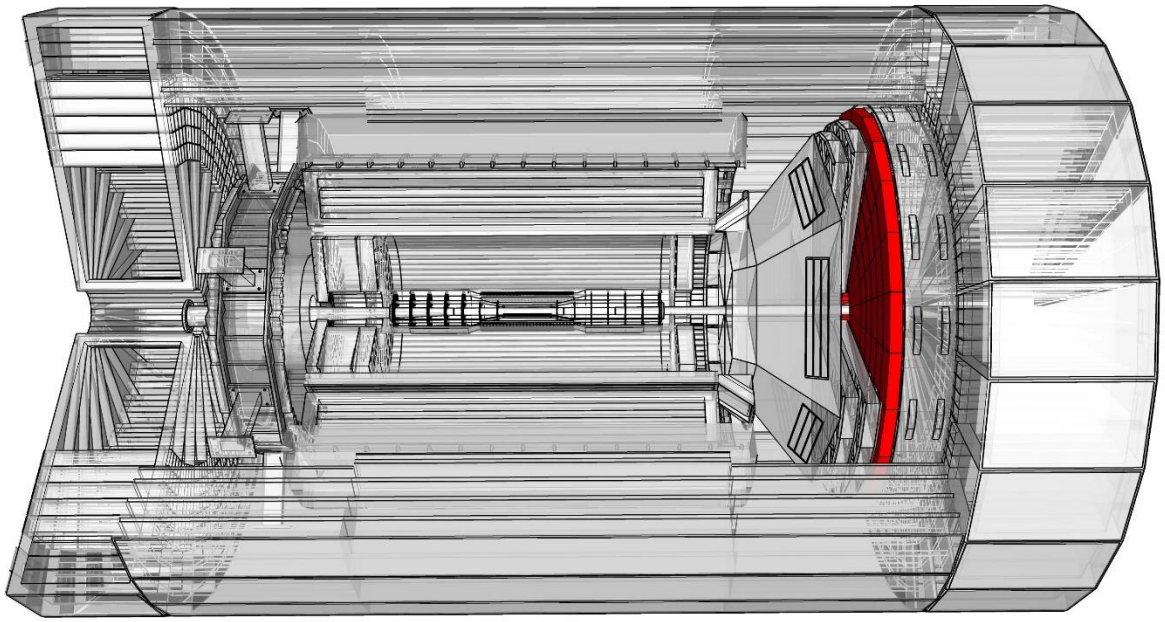

Figure 18: Hadron Direction Time of Flight Detector

Dimensions/Location

Overall Length	10 cm
Bore	20 cm
Radius	180 cm
Offset	290 cm in Hadron Direction
Total Volume	1.01 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (PANDA)	605 kg/m³	609 kg
Cabling		
	Total:	609 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

HADRON DIRECTION ELECTROMAGNETIC CALORIMETER

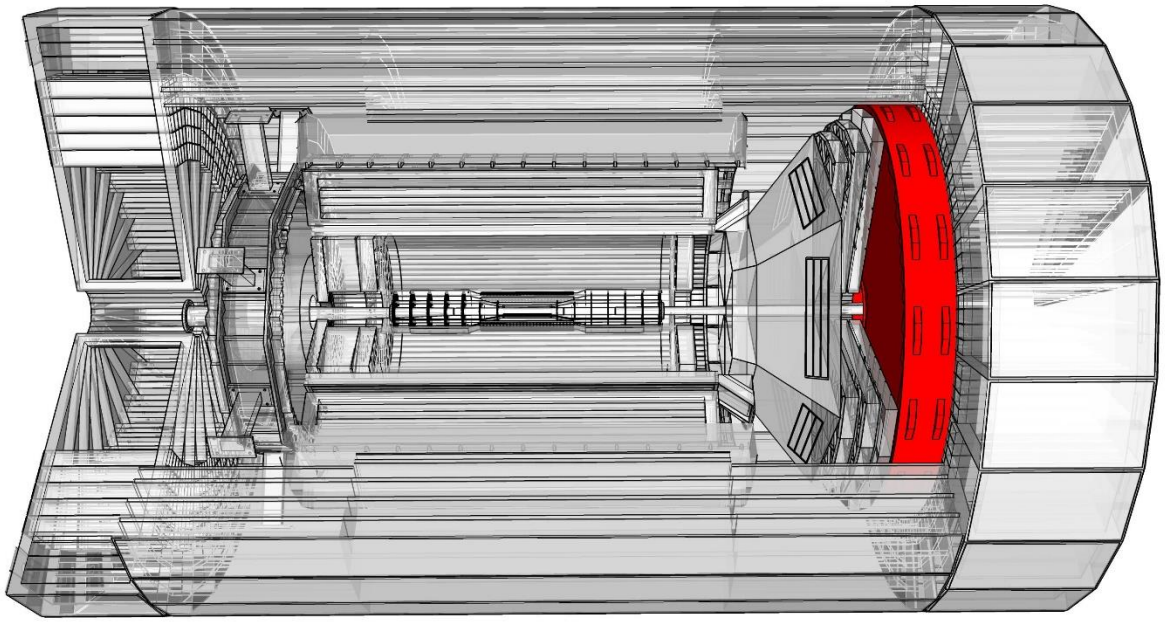

Figure 19: Hadron Direction Electromagnetic Calorimeter

Dimensions/Location

Overall Length	40 cm
Bore	30 cm
Radius	190 cm
Offset	300 cm in Hadron Direction
Total Volume	4.42 m³

Weight Estimates

Element	*Basis*	*Weight*
4.3 m³ of Lead Glass	6,220 kg/m³	26,764 kg
0.12 m³ of Steel	7,850 kg/m³	946 kg
Cabling		
	Total:	27,710 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA SILICON VERTEX DETECTOR

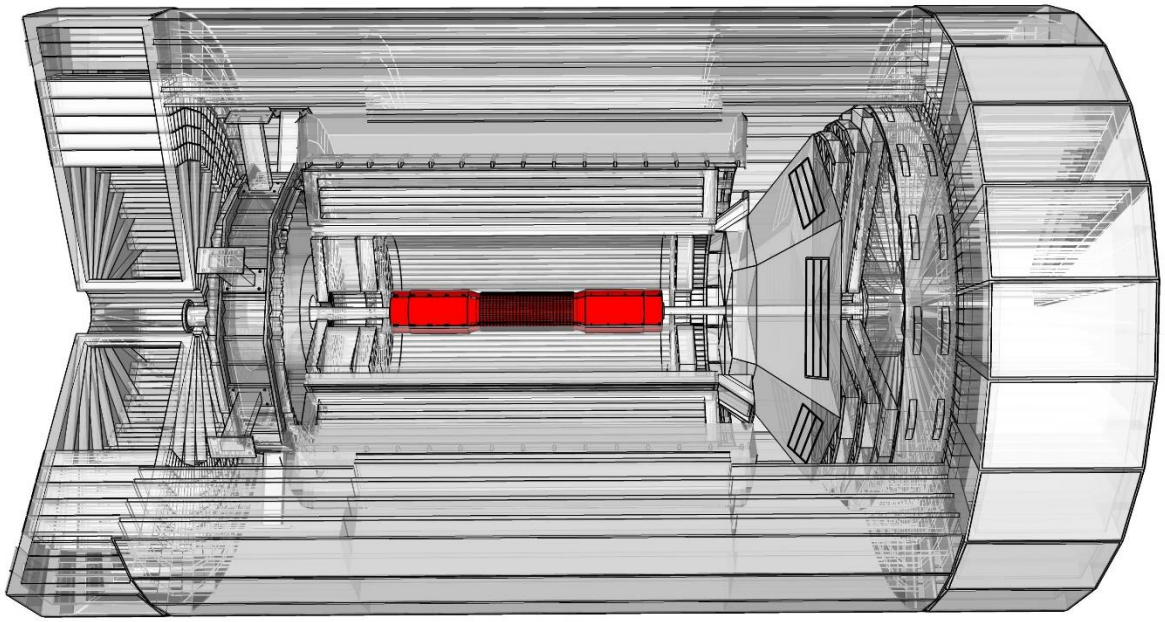

Figure 20: Silicon Vertex Detector

Dimensions/Location

Overall Length	244 cm
Bore	0 cm
Radius	19.8 cm
Offset	0 cm
Total Volume	0.30 m³

Weight Estimates

Element	*Basis*	*Weight*
0.009 m³ of Aluminum	2,710 kg/m³	24 kg
0.009 m³ of Silicon	2,330 kg/m³	21 kg
Cabling		
	Total:	45 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA VACUUM CHAMBER

Note that this vacuum chamber is specific to IP-6. An alternate design will be produced for IP-8.

Figure 21: Vacuum Chamber (Top View)

Dimensions/Location

Overall Length	645.28 cm
Beryllium Length	146.05 cm
Interior Section Length	243.90 cm
Lepton Section Length	Not Available
Hadron Section Length	Not Available

Weight Estimates

Element	*Basis*	*Weight*
Data Not Collected		
	Total:	lbs
		tons

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

ALTERNATE DIRC: BARREL SUPPORT

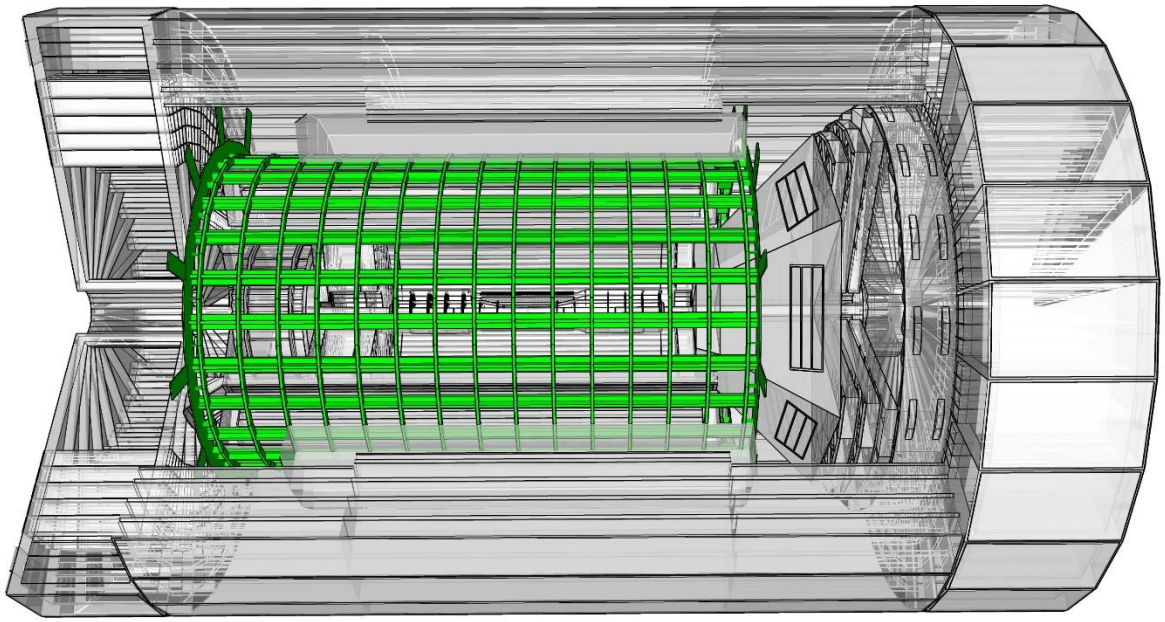

Figure 22: Barrel Support

Dimensions/Location

Structure Length	455 cm
Radius	142 cm
Support Radius	194 cm
Offset	35 cm in Lepton Direction

Weight Estimates

Element	*Basis*	*Weight*
Data Not Collected		
	Total:	lbs
		tons

1.5 TESLA

ALTERNATE DIRC: BARREL ELECTROMAGNETIC CALORIMETER

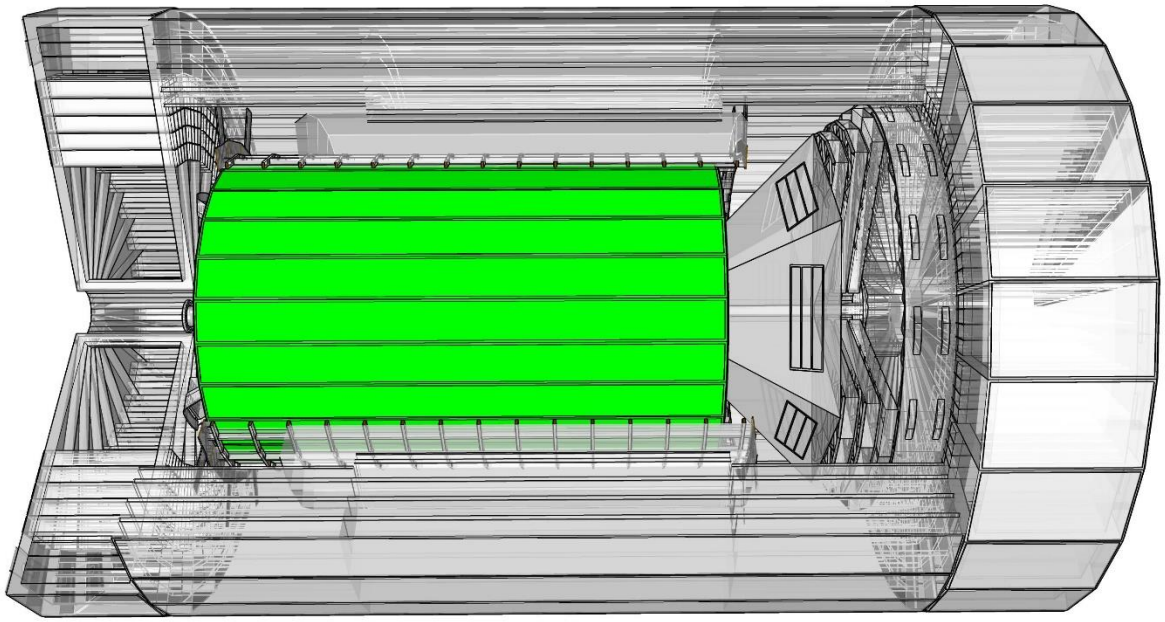

Figure 23: Barrel Electromagnetic Calorimeter

Dimensions/Location

Overall Length	430 cm
Bore	84 cm
Radius	134 cm
Offset	46 cm in Lepton Direction
Total Volume	14.72 m³

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CMS)	3,508 kg/m³	51,655 kg
Cabling		
	Total:	51,655 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA ALTERNATE DIRC: DIRC DETECTOR

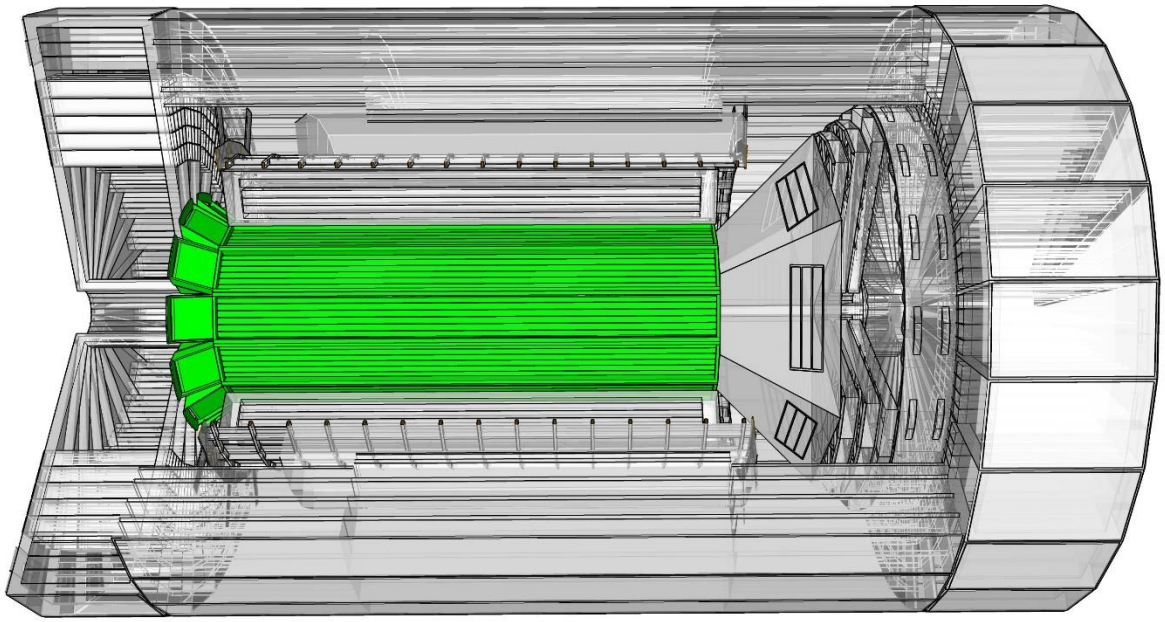

Figure 24: DIRC Detector

Dimensions/Location

DIRC Bar Length	430 cm
DIRC Segment Count	12
Bore	N/A
Radius	81 cm
Offset	262 cm in Lepton Direction
Total Volume	0.88 m^3

Weight Estimates

Element	*Basis*	*Weight*
0.17 m^3 of Steel	7,850 kg/m^3	1,368 kg
0.71 m^3 of Quartz	2,320 kg/m^3	1,644 kg
Cabling		
	Total:	3,012 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA

ALTERNATE DIRC: LEPTON DIRECTION ELECTROMAGNETIC CALORIMETER

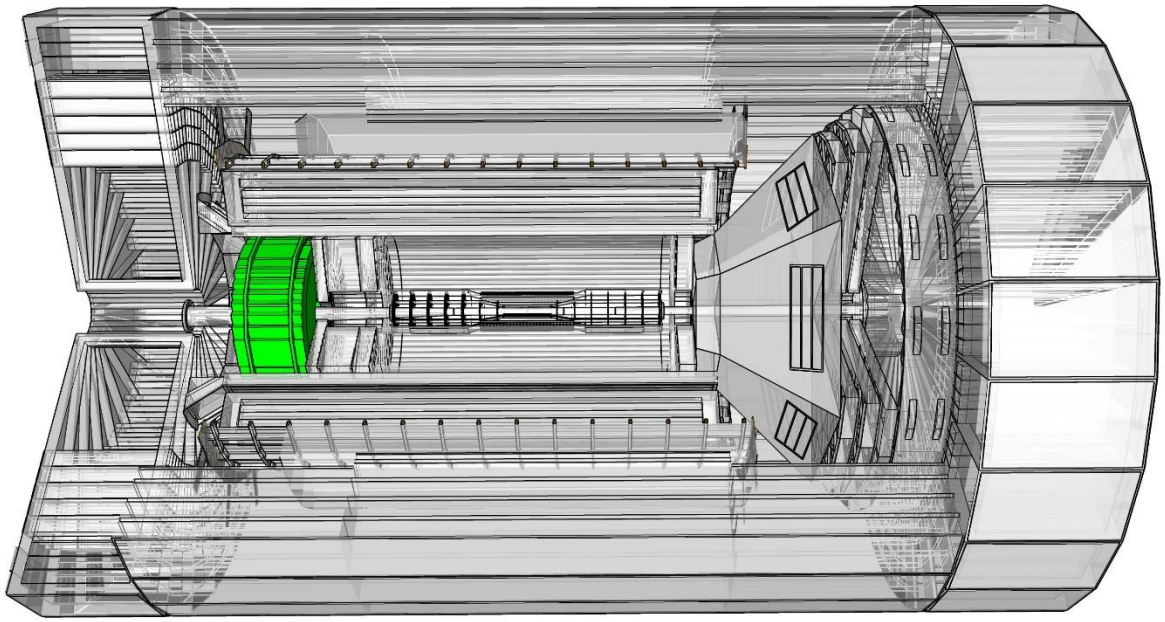

Figure 25: Lepton Direction Electromagnetic Calorimeter

Dimensions/Location

Overall Length	60 cm
Bore	15 cm
Radius	61 cm
Support Sides	12
Support Radius	69 cm
Offset	190 cm in Lepton Direction
Total Volume	0.68 m³

Weight Estimates

Element	*Basis*	*Weight*
0.7 m³ of Lead Glass	6,220 kg/m³	4,100 kg
0. m³ of Steel	7,850 kg/m³	130 kg
Cabling		
	Total:	4,231 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	

1.5 TESLA ALTERNATE DIRC: RICH (RING IMAGING CHERENKOV) DETECTOR

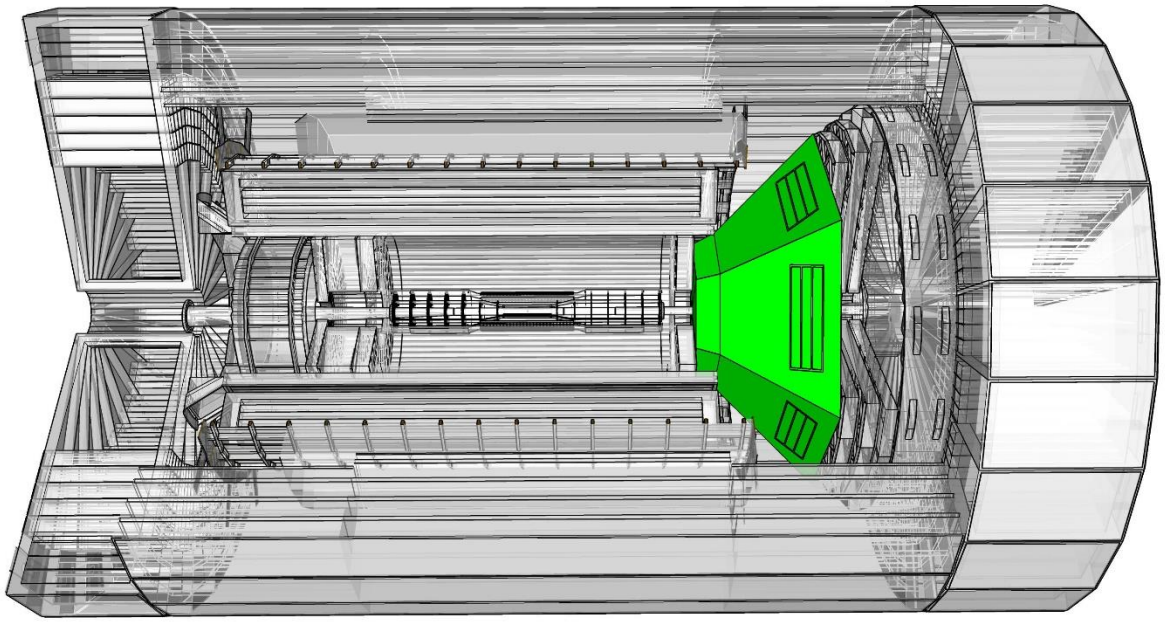

Figure 26: RICH Detector

Dimensions/Location

Overall Length	110 cm
Aerogel Length	20 cm
Aerogel Radius	60 cm
Detector Length	90 cm
Bore	10 cm
HD Radius	160 cm
LD Radius	70 cm
Offset	260 cm in Hadron Direction
Segment Count	6
Total Volume	4.20 m^3

Weight Estimates

Element	*Basis*	*Weight*
Volume Coeff (CLAS LTCC)	185.81 kg/m^3	780 kg
Cabling		
	Total:	780 kg

Power Requirements

Component	*Source/Voltage*	*Amps*
Data Not Collected		

Heat Dissipation

Removal Mechanism/Medium	*BTUs*
Data Not Collected	

Communications/Signal

Element	*Cables/Connections*
Data Not Collected	